M_PACK

Reference Guide

by

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Contents

1 Introduction

The M_PACK is a set of Matlab functions and utilities useful for many different purposes. An important part of M_PACK is related with data extraction and visualisation of NetCDF data, especially from ROMS (Regional Ocean Model System) input and output files. It is a collection I created during the last four years in the context of my research in ocean modelling. My attempt was to create something as generic and simple as possible. It was and still is very useful for me and I hope it will make your life easier too.
Included in M_PACK are also tools created by other authors, mainly related with Physical Oceanography. These authors are properly referenced in this text and all the files are freely available online. Some of the other authors functions are actually required by my own.

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2 M_PACK Installation

M_PACK is free and available for download at:

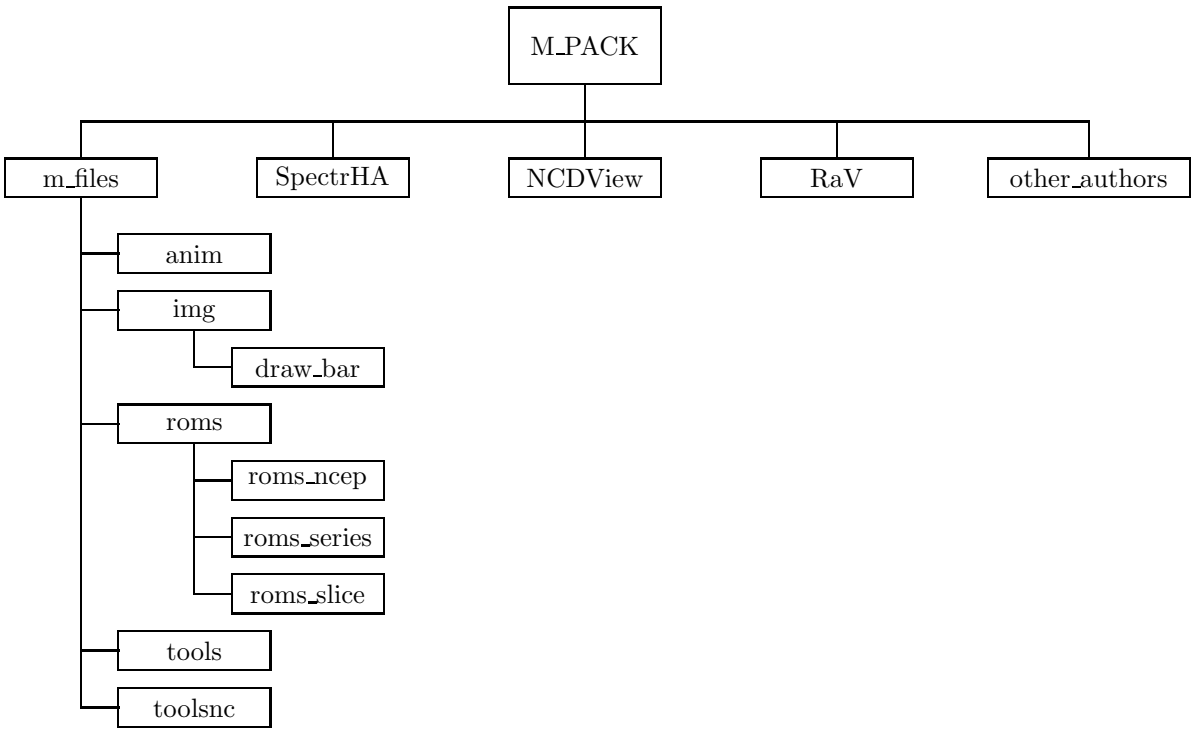
`http://neptuno.fis.ua.pt/~mma`

After unpack, the base directory containing the matlab function m_pack.m should be added to the matlab path. Then you just need to run *m_pack('start')* at the matlab prompt and all the M_PACK utilities will be ready to use. Read the help of this function for additional information.
If you find any bugs or have some questions/suggestions, you may contact me using the email:

`martinho@fis.ua.pt`

3 M_PACK Structure

M_PACK is divided in five parts. The first, m_files, contains a large set of functions to perform several types of tasks, from creating drawings till make basic calculations. The next three parts are GUIs for data visualisation and analysis. The first GUI, SpectrHA, is a tool for harmonic analysis of series, mainly directed to analysis of data from the output stations file of the ocean model ROMS. The second, NCDView is a GUI to easily and rapidly visualise NetCDF files. It allows to make simple plots and slices of NetCDF variables. The third is Rav, a rather complex utility to visualise ROMS input and output files. RaV is still under development but it works fine and it is very easy to make slices, time series and vertical profiles of several variables.
Also included in M_PACK are utilities from other authors. They will be discussed in section 9.
Bellow you can see the M_PACK structure. In the following sections each part of M_PACK is described and a small information about all functions from m_files, with some examples, is given.



4 m_files

4.1 anim

The anim section contains functions related with the creation and manipulation of animations mainly in the FLI/FLC [3] format. Some of these functions only work in UNIX like machines and there are a few requirements.
More information about the creation of FLI/FLC animations can be found online, see [4, 5].

Function	Description	OS	Requirements
append_anim	Join two FLI/FLC animations	UNIX	ImageMagic [7]
dta2fli	Create FLI/FLC animations on Windows	PCWIN	DTA [8]
fixedar	Set figure PaperPosition as Position		
get_tiff	Print current image		
ppm2fli	Create FLI/FLC animations on UNIX like machines	UNIX	ppm2fli [3]
resize_anim	Resize FLI/FLC animation	UNIX	ImageMagic
tiff2ppm	Convert image (tif) to another (ppm)		ImageMagic

anim: Creation and manipulation of FLI/FLC animations.

4.2 img

Under img you find functions related with the creation of simple drawings, like arrows, ellipses,... and manipulation of figure properties.

Function	Description
auto_color	Set different colors to axis handles
ax_pos	Show mouse position
cone3d	Draw arrow 3D
contourz	3D contour plot on a surface
copy_figure	Copy objects of an axis to another
cyl	Draw cylinder
dist_label	Insert distance label
fill_box	Fill rectangle
geodist	Display distances on axis
geo_labels	Format tickLabels
isprop	Check handle property
m_axis	Set axis limits
m_clabel	Modified version of clabel
m_input	Graphical input from mouse
myhist	Histogram, another version
myhist2	Histogram, another version, horizontal
mystem	Modified version of stem
north_arrow	Draw direction arrow
plot_axis	Plot axes on current axis
plot_box	Plot rectangle
plot_ellipse	Draw ellipse using major, minor, inc and phase
plot_tidestruc	Plot ellipses from LSF or T_TIDE output
seta2d	Plot 2D filled arrow
sph	Draw sphere taking in account DataAspectRatio
sph2	Draw circle taking in account DataAspectRatio
ud_handles	Change position of current axis children
vector	Draw arrow 2D or 3D (w=0)
vector2d	Draw arrow 2D
w_rose	Draw wind rose
wind_arrow	Plot wind direction
wind_rose	Draw wind rose

img: Creation and manipulation of graphics.

4.2.1 draw_bar

The draw_bar is a set of funny tools that I created in some inspired night... It includes some few tools to draw with the mouse rectangles, splines,... maybe useful to select some region of the graphic or whatever.

Function	Description
blin	Add broken line to current axis
circ	Add circumference to current axis
draw_bar	Add drawing utilities to current figure
spl	Add spline line to current axis
sqr	Add rectangle to current axis
toggle_objs	Toggle DRAW_BAR objects

draw_bar: Drawing utilities.

4.3 roms

In this section there are functions related with the creation, manipulation and visualisation of NetCDF [2] input and output files of the model ROMS [1].

Function	Description
bat_smooth	Smooth ROMS NetCDF grid file
editmask	Edit land mask of ROMS NetCDF grid file
fill_border	Fill around ROMS region
flt_age	Get ROMS float age
get_sigma	Get s-coordinates parameters from ROMS file (deprecated)
get_sta	Get vertical profile of a ROMS variable
m_hslope[†]	Compute bathymetry slope
plot_border	Plot ROMS rho border/extremes box
plot_border2d	Display ROMS grid 2D
plot_border3d	Display ROMS grid boundaries
roms_border	Get ROMS region border
roms_dt	Get time info from ROMS output file
roms_extractstr	Get range of ROMS NetCDF variables
roms_grid	Get ROMS grid data x, y, h and mask
ruse	Extract ROMS NetCDF variables
s_levels	Get vertical s-coordinates levels
s_params	Get s-coordinates parameters from ROMS file
show_mask	Display mask from ROMS grid or history file
sta_grid_pos	Plot ROMS stations location
sta_time	Get interval and length of ROMS output stations
sta_yx	Get dimensions of longitude in ROMS stations file

roms: Data extraction and visualisation of ROMS NetCDF files.

4.3.1 roms_ncep

Here you find functions for the creation of ROMS fluxes forcing files from the NCEP [6] reanalysis database. All you need to provide is the grid name, the initial and final time, then, sit back, light a cigar, and let the computer download the required files, compute everything and after you have finished the cigar your files are ready.
This task require the NetCDF executable *ncgen* and the the *wget* (to download the files, unless you get them by hand).

[†]Modified version of hslope (Rutgers University).

Function	Description
ncep_gen[†]	Generate ROMS bulk fluxes forcing files from NCEP
ncep_gencdl	Create NetCDF cdl and nc file of ROMS bulk forcings
ncep_genfrc	Create NetCDF ROMS bulk forcing file
ncep_getfile	Download NCEP reanalysis file
ncep_getvar	Get NCEP bulk flux variable
ncep_istart	Get start and end time indices in NCEP files
ncep_settings	Information about NCEP bulk fluxes files
ncep_uvcomp	Compare NCEP winds of several years
ncep_var2grid	Interpolate NCEP variable to ROMS grid

roms_ncep: Creation of ROMS bulk fluxes forcing files from NCEP database.

4.3.2 roms_series

Functions to extract time series from ROMS files, namely from the stations file. These functions allow also the extraction of vertical profiles at a desired location.

Function	Description
roms_ts	Extract time series and z-profiles from ROMS output
roms_tsf	Filter ROMS time series

roms_series: Extraction of time series and z-profiles from ROMS output NetCDF files.

4.3.3 roms_slice

In roms_slice there are functions to extract slices of ROMS variables. Several type of slices are available. These functions where created in the context of RaV (ROMS Visualisation utility) and are mainly directed to be used with ROMS output history files. The introduction of some small modifications allowed them to be used also with ROMS_AGRIF [9].

Function	Description
roms_slice[‡]	Utility to extract 2D slices from ROMS output
roms_slicei	Make ROMS slice across eta direction (i=const)
roms_slicej	Make ROMS slice across xi direction (j=const)
roms_slicek	Make ROMS slice at s-level (k=const)
roms_slicelat	Make ROMS slice across meridional direction (lat=const)
roms_slicelon	Make ROMS slice across zonal direction (lon=const)
roms_sliceuvw	Get velocity field at ROMS slice
roms_sliceuvw3	Get 3D velocity field at ROMS slice
roms_slicez	Make ROMS slice at z=const

roms_slice: Extraction of 2D slices from ROMS output NetCDF files.

4.4 tools

This section has function mainly to make several types of calculus, but also a lot of miscellaneous stuff.

[†]ncep_gen is the main file, better start by reading the help of this file.

[‡]This is the main file and includes important information in the help. You should read it before use the other functions, specially in what concerns the approximations used.

Function	Description
atan3	Inverse tangent [0:360[
cc	Clear and close all
corr_xy	Correlation coefficient between two series
deg2rad	Degree to radian conversion
dsp	Run UNIX display
explode	Divide a string by a character
file_list	List files of a directory
freq2name	Convert tidal frequency to name
fsa	Fourier Spectral Analysis
getf	Get filename
gv	Run UNIX gv
hv_dist	Compute number of grid points according to resolution
integ	Riemann integration
interp2pi	Angles interpolation
isnumber	Check if numeric value
lon2xcoast	Convert lon/lat to distance to coast
lsf	Harmonic analysis of time series using Least Squares Fit
m_smooth	Smooth 2D array
maf	Moving Average Filter
mat_tex	Create latex table with matlab matrice
max_min	Get extremes of series
mc_read	Read multi column text file
name2freq	Convert tidal name to frequency
nan2zero	Convert NaNs to zero
nan_count	Count NaNs
rad2deg	Radian to degree conversion
rot2d	2D rotation
rot3d	3D rotation
rot_longitude	Swap longitude between -180:180 and 0:360
sign_swap	Get indices of sign change
smooth_r	Smooth 2D array with a square filter
sph_dist	Shortest distance between two points on a sphere
subname	Get part of string
t0_t_tide	Adjust T_TIDE output to beginning of series
td_read	Time data read
var_border	Get border of 2D array
vi	Run UNIX vi
zero2nan	Convert zeros to NaN

tools: Mathematical and miscellaneous tools.

4.5 toolsnc

This is a small set of functions to deal with NetCDF data. You can check the contents of files, get attributes of files/variables, etc.

Function	Description
n_fileatt	Get global attributes of NetCDF file
n_fileattexist	Check if NetCDF file attribute exists
n_filedim	Get dimensions of NetCDF file
n_filedimexist	Check if NetCDF file dimension exists
n_vararraydim	Get array dimension of a NetCDF variable, range or size
n_varatt	Get attributes of NetCDF variable
n_varattexist	Check if NetCDF variable attribute exists
n_vardim	Get dimensions of NetCDF variable
n_vardimexist	Check if NetCDF variable dimension exists
n_varexist	Check if NetCDF variable exists
n_varscale	Get scale and offset of NetCDF variable
n_varsize	Get size of a NetCDF variable or range
show	Display contents of NetCDF file
use	Load NetCDF variable

toolsnc: Extraction of information from NetCDF files.

5 m_files examples

In this section are shown a few examples of the m_files utilities.

5.1 anim

Small example of how to create an animation:

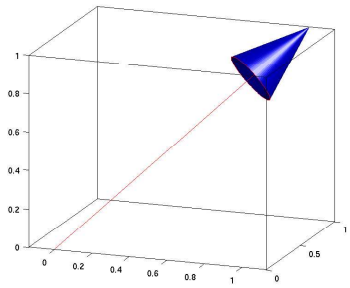
```
for i=1:n
  plot...
  get_tiff(i);  % will produce image_0001.tif, image_0002.tif...
end
tiff2ppm
ppm2fli('*.ppm','anim.flc',5,'300x500');  % UNIX
dta2fli('image*.png','myanim','c:\dta\'); % PCWIN
```

The function ppm2fli will create anim.flc using all ppm files of current dir. The animation will run in 5 frames per second and will have dimension of 300 by 500 px. This works only in UNIX like machines. For PCWIN, dta2fli will use all png files image*.png and creates myanim.flc using `c:\dta\dta.exe`. Under UNIX, ppm is a good format, for PCWIN better use png with dta.exe.
In order to obtain images with size equal to the size on screen, get_tiff prints the current figure with the options -r0 -zbuffer (by default). This is explained in the get_tiff help. The -r0 option specifies the use of the screen resolution. The -zbuffer option more likely gives output that emulates the screen. For some image formats, like tiff ans ps these options should be used. Of course, if you don't want the animation size as you see on screen, forget about this and use get_tiff with different options.

5.2 img

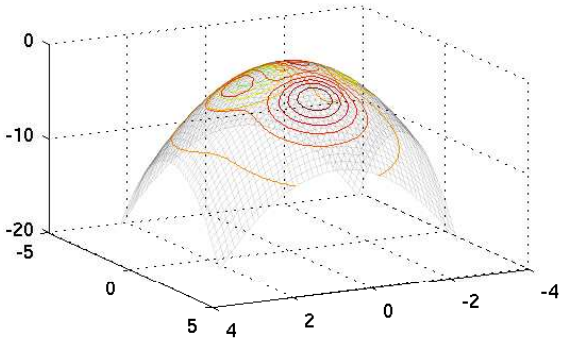
cone3d

```
handle=cone3d([0 0 0],[1 1 1],20,'.4')
axis equal, box on, grid off, light,view([20 15])
```



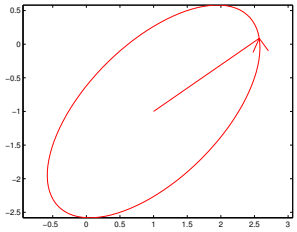
contourz

```
[x,y,v] = peaks;
z=-(x.^2+y.^2);
surf(x,y,z,'facecolor','none','edgealpha',.1)
contourz(x,y,z,v);
% put labels:
view(2)
contourz('clabel');
view(3)
```



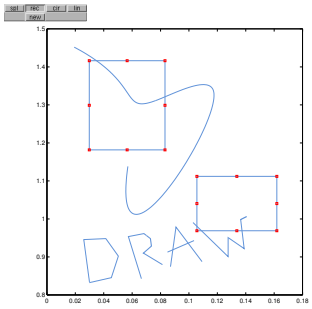
plot_ellipse

```
plot_ellipse(2,1,45,20,[1 -1],'r'), axis equal
```



5.3 draw_bar

The draw_bar command inserts a few buttons in current figure that can be used to make some basic drawings.



5.4 roms

s_params

```
file = 'ocean_his.nc';
[theta_s,theta_b,hc,n] = s_params(file);

s_params(file)

## s-levels parameters of file
ocean_his.nc

  --> theta_s    3.00  variable
  --> theta_b    0.40  variable
  --> hc         5.00  variable
  --> N         25.00  file dimension N
```

s_levels

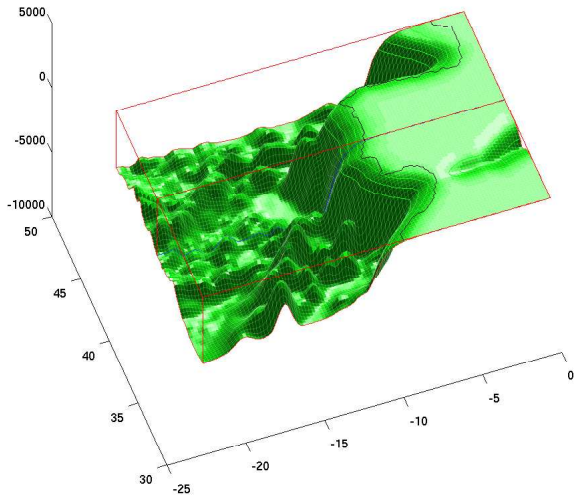
```
[z_r,z_w] = s_levels(100,5,.3,5,5,0)

z_r =
  -72.2893  -42.4626  -21.0004   -5.6755   -0.9266

z_w =
 -100.0000  -54.7605  -31.7615  -11.6817   -2.5237         0
```

plot_border3d

```
file = 'ocean_his.nc';
plot_border3d(file,'slicej',50), camlight
```



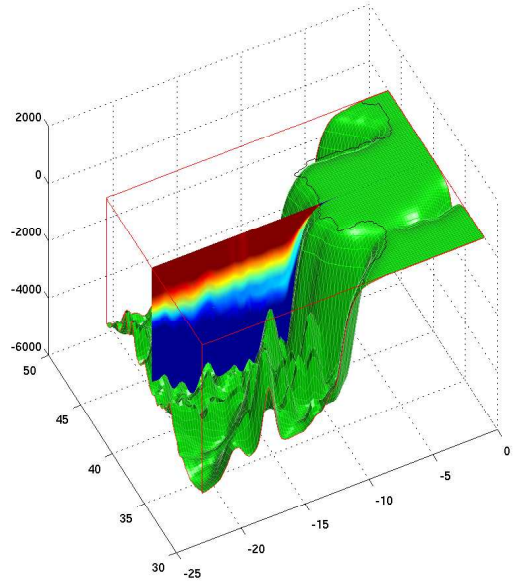
5.5 roms_slice

Some slices require s-coordinates parameters. The roms_slice tools use the s_params function to find these parameters among variables, file attributes and dimensions. However, is they are not present or if you want to use other different parameters, they can be used as varargin. An example of roms_slicej follows.

roms_slicej

```
file = 'his.nc';
varname = 'temp';
j = 50;
t = 10;
params.tts  = 5;
params.ttb  = .3;
```

```
params.hc   = 5;
params.N    = 20;
[x,y,z,v,labels]=roms_slicej(file,varname,j,t,'s_params',params);
% this is the same as:
% [x,y,z,v,labels]=roms_slice(file,'slice','slicej','variable',varname,...
%                             'ind',j,'time',t,'s_params',params);
s=surf(x,y,z,v);
set(s,'facecolor','interp','edgecolor','none');
caxis([10 14])
plot_border3d(file,'slicej',j);
camlight
set(s,'facelighting','none')
```



5.6 tools

lsf

```
% f is real
t=0:24*10;
y=cos(2*pi*t/12-30*pi/180)+2*cos(2*pi*t/12.42060-80*pi/180);
[tidestruc,xout]=lsf(t,y,['M2';'S2']);

==================================================
  Least Squares Fit Harmonic Analysis
 Date: 16-Dec-2004 23:17:43
 Serie Length: 241
 Interval: 1.00 h
 Days: 10.00
--------------------------------------------
       Period    Amp      Pha
M2  12.4206   2.0000   79.9997
S2  12.0000   1.0000   30.0000

 correlation: 1
==================================================

% f is imag
t=0:24*30;
u=cos(2*pi*t/12-30*pi/180);
v=cos(2*pi*t/12);
f=u+sqrt(-1)*v;
```

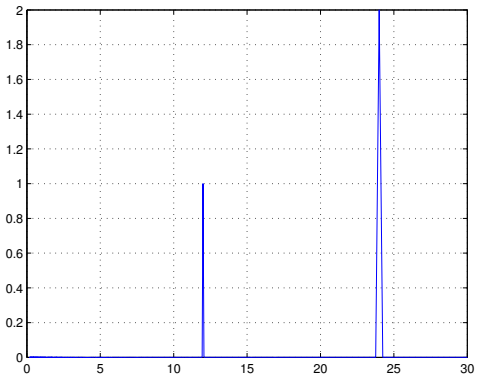
```
[tidestruc,xout]=lsf(t,f,['M2';'S2']);
=====================================================
  Least Squares Fit Harmonic Analysis
 Date: 16-Dec-2004 23:17:43
 Serie Length: 721
 Interval: 1.00 h
 Days: 30.00
-----------------------------------------
       Period   major    minor    inc        pha
M2  12.4206   0.0000  -0.0000   45.2526     8.7663
S2  12.0000   1.3660  -0.3660   45.0000    15.0000

 correlation: 1+1i
=====================================================
```

fsa

```
interval=.1;
t=0:interval:24*100;
y=cos(2*pi*t/12-30*pi/180)+2*cos(2*pi*t/24-80*pi/180);
s=fsa(y,interval);
%s=fsa(y,interval,'file.dat');
plot(s.T,s.amp), xlim([0 30]); grid

*****************************************
   Fourier Spectral Analysis
 Date: 16-Dec-2004 23:20:47
 Serie Length: 24000
 Interval: 0.10 h
 Days: 100.00
 a0: 0.0000
 Main signs
-----------------------------------------
    Period     Amp      Pha
   24.0000    2.0000    80.0000
   12.0000    1.0000    30.0000
    0.4800    0.0000   220.8378
    0.5106    0.0000   289.6992
    0.4898    0.0000   272.4239
    0.5217    0.0000   341.7179
    0.2719    0.0000   217.3209
    0.2814    0.0000   286.9003
    0.2688    0.0000   167.3638
    0.2782    0.0000   236.6715
*****************************************
```



5.7 toolsnc

show
This is an imitation of the Ferret[†] command show.

```
file = 'ocean_grd.nc';
show(file)

## Data in NetCDF file
/home/you/ocean_grd.nc

 [scale(*) offset(*) - Var - Size]

-- xl           1  1
-- el           1  1
-- JPRJ         2  1
-- PLAT         2  1
-- PLONG        1  1
-- ROTA         1  1
-- JLTS         2  1
-- P1           1  1
-- P2           1  1
-- P3           1  1
-- P4           1  1
-- XOFF         1  1
-- YOFF         1  1
-- depthmin     1  1
-- depthmax     1  1
-- spherical    1  1
-- hraw         1  226  122
-- h            226  122
-- f            226  122
...


show(file,[1 1],30)

## Data in NetCDF file
/home/you/ocean_grd.nc

 [scale(*) offset(*) - Var - Long_Name - Size - Units]

-- xl           domain length in the XI-d  1  1          meter
-- el           domain length in the ETA-  1  1          meter
-- JPRJ         Map projection type        2  1
-- PLAT         Reference latitude(s) for  2  1          degree_north
-- PLONG        Reference longitude for m  1  1          degree_east
-- ROTA         Rotation angle for map pr  1  1          degree
-- JLTS         How limits of map are cho  2  1
-- P1           Map limit parameter numbe  1  1
-- P2           Map limit parameter numbe  1  1
-- P3           Map limit parameter numbe  1  1
-- P4           Map limit parameter numbe  1  1
-- XOFF         Offset in x direction      1  1          meter
-- YOFF         Offset in y direction      1  1          meter
-- depthmin     Shallow bathymetry clippi  1  1          meter
-- depthmax     Deep bathymetry clipping   1  1          meter
-- spherical    Grid type logical switch   1  1
-- hraw         Working bathymetry at RHO  1  226  122   meter
-- h            Final bathymetry at RHO-p  226  122      meter
-- f            Coriolis parameter at RHO  226  122      second-1
...
```

[†] http://ferret.wrc.noaa.gov/Ferret

n_fileatt

```
file='his_agrif.nc';
n_fileatt(file);

 Attributes in NetCDF file
 his_agrif.nc

  --> type             ROMS history file
  --> title            IBERIAN TEST MODEL
  --> date             <empty>
  --> rst_file         roms_rst.nc
  --> his_file         roms_his.nc
  --> avg_file         roms_avg.nc
  --> grd_file         roms_grd.nc
  --> ini_file         roms_ini.nc
  --> frc_file         roms_frc.nc
  --> theta_s          <numeric: 7>
  --> theta_s_expl     S-coordinate surface control parameter
  --> theta_b          <numeric: 0>
  --> theta_b_expl     S-coordinate bottom control parameter
  --> Tcline           <numeric: 5>
  ...
```

n_varatt

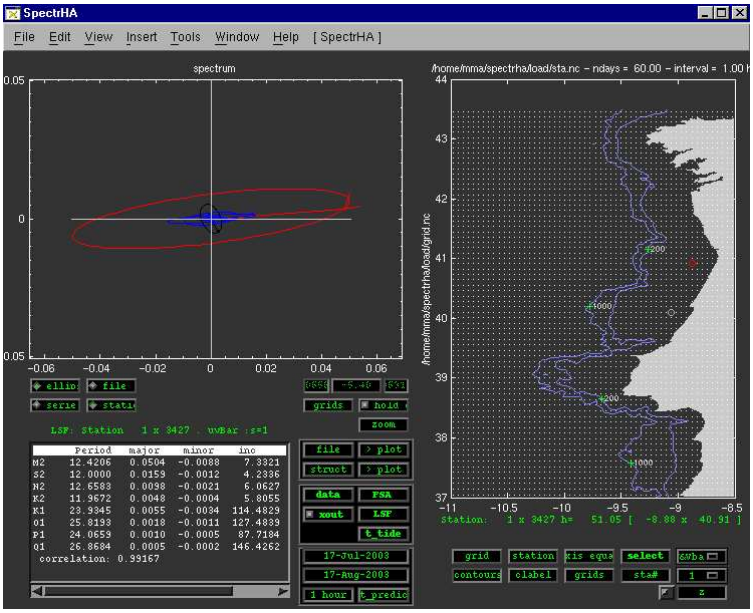
```
file='his_agrif.nc'1;
n_varatt(file,'temp')

 Attributes in variable temp from NetCDF file
 his_agrif.nc

  --> long_name     potential temperature
  --> units         Celsius
  --> field         temperature, scalar, series
```

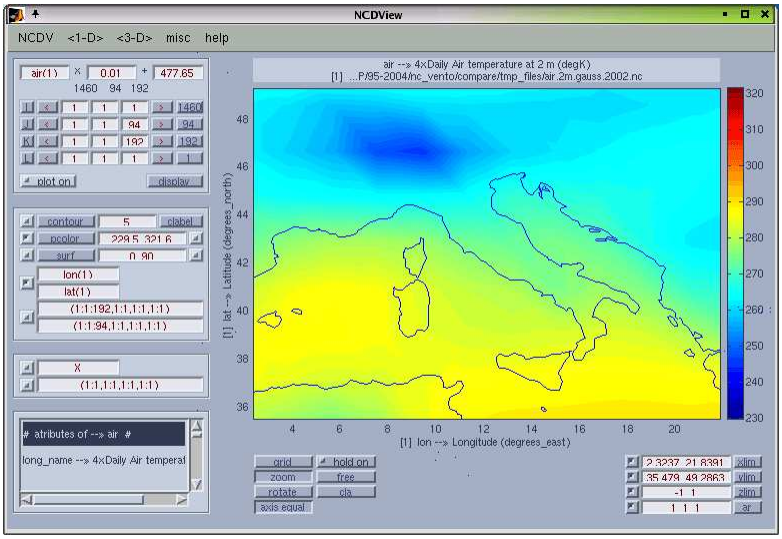
6 SpectrHA

SpectrHA is a tool to execute Fourier Spectral Analysis and Harmonic Least Squares Fit analysis of series. It's designed to be used with the output of the oceanographic model ROMS (Regional Ocean Model System), but can easily be changed to use any other sources.
It is fully described at `http://neptuno.fis.ua.pt/~mma/SpectrHA`. There are two versions, the original SpectrHA and SpectrHA2. The version 2 allows to see the vertical structure of tidal harmonic parameters.
These GUIs are called at matlab prompt with *spectrha* and *spectrha2* respectively.
A screenshot follows:



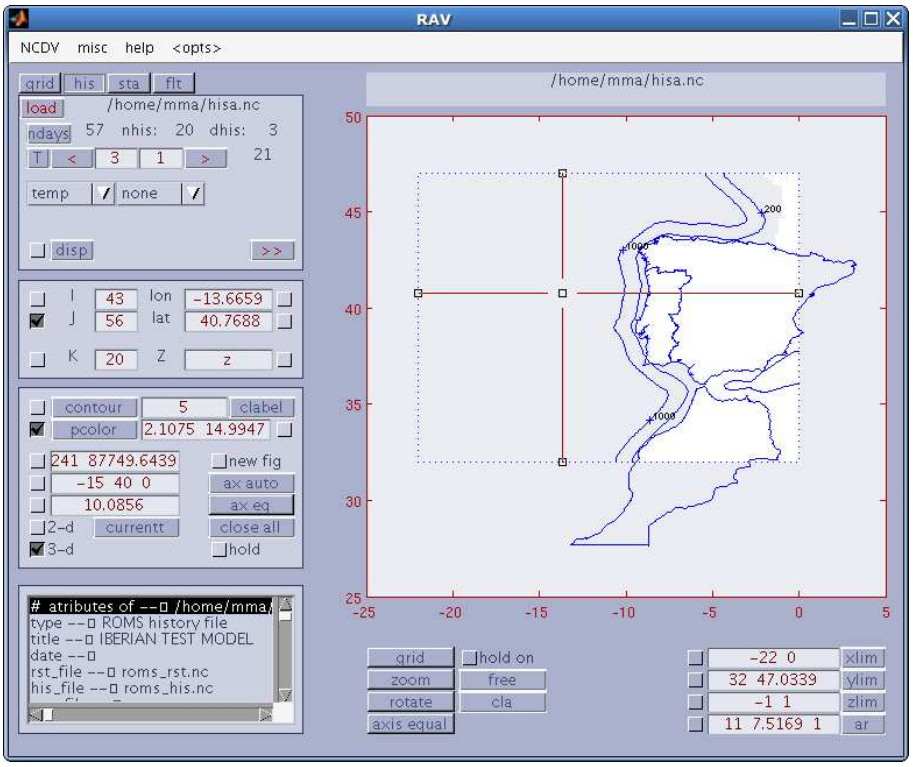
7 NCDView

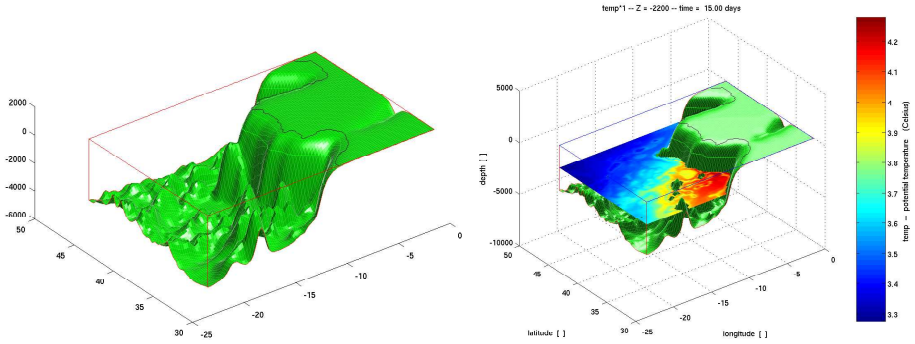
This is a very simple GUI for NetCDF visualisation. You can use it to rapidly see the contents of a file, the attributes of the variables and make plots. You can use many different files and plot variables from multiple files.
NCDView is called from the matlab prompt by *ncdv* and is fully described at `http://neptuno.fis.ua.pt/~mma/NCDView`.
A screenshot follows:



8 RaV

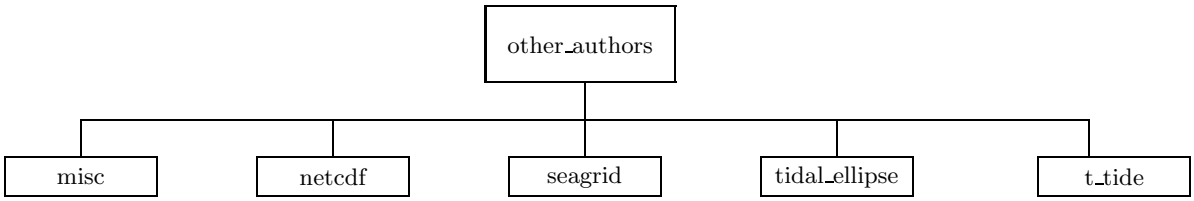
RaV, ROMS Visualisation, is a GUI to easily make slices and plots of ROMS input and output files. It is based on roms_slice and roms_series described above. To call Rav from the matlab prompt, use *rav*.





9 other_authors

Included in M_PACK are some tools created by other authors. Some of the functions in this section are required by the previously described applications and others are just very useful for ocean modelling.
All the contents of other_authors are freely available at SEA-MAT [10].
The contents:



9.1 misc

Here are few functions that may be useful. Currently it contains functions to compute land/sea mask, the wind stress and some low-pass filters. The authors are Bob Beadsley, Rich Signell and Herman Arango.

9.2 netcdf

The netcdf interface for matlab is included here. It should work for PCWIN and Linux (matlab 5, 6 and 7). If you find problems in your platform consult the site *MexCDF and NetCDF Toolbox For Matlab-5&6* [11].

9.3 seagrid

Seagrid is an application for orthogonal grids generation, suitable for the ROMS model and others. It should work for PCWIN and Linux. See the site *SeaGrid Orthogonal Grid Maker For Matlab* [12] for more information.

9.4 tidal_ellipse

Tool from Zhigang Xu to convert between tidal amplitude and phase into tidal ellipse parameters.

9.5 t_tide

This is a widely used package for tidal harmonic analysis.
It was created by Rich Pawlowicz and is described in:
Pawlowicz, B. Beardsley, and S. Lentz, "Classical tidal harmonic analysis including error estimates in MATLAB using T_TIDE, Computers and Geosciences 28 (2002), 929-937.
For more information see the site *Rich Pawlowicz's Matlab Stuff* [13].

Links

[1] ROMS, Regional Ocean Model System
http://marine.rutgers.edu/po/index.php?model=roms

[2] NetCDF, network Common Data Form
http://my.unidata.ucar.edu/content/software/netcdf

[3] FLI animations
http://vento.pi.tu-berlin.de/fli.html

[4] FLI animations tools
http://neptuno.fis.ua.pt/~mma/etc/anims/anims.htm

[5] The FLI/FLC Animation Format
http://woodshole.er.usgs.gov/operations/modeling/flc.html

[6] NCEP/NCAR Reanalysis 1
http://www.cdc.noaa.gov/cdc/data.ncep.reanalysis.html

[7] ImageMagick
http://www.imagemagick.org

[8] Dave's Targa Animator
http://www.povray.org/ftp/pub/povray/utilities/dta

[9] ROMS_AGRIF
http://www.brest.ird.fr/Roms_tools

[10] SEA-MAT, Matlab Tools for Oceanographic Analysis
http://woodshole.er.usgs.gov/operations/sea-mat

[11] MexCDF and NetCDF Toolbox For Matlab-5&6
http://woodshole.er.usgs.gov/staffpages/cdenham/public_html/MexCDF/nc4ml5.html

[12] SeaGrid Orthogonal Grid Maker For Matlab
http://woodshole.er.usgs.gov/staffpages/cdenham/public_html/seagrid/seagrid.html

[13] Rich Pawlowicz's Matlab Stuff
http://www2.ocgy.ubc.ca/~rich